History of Soil Bioengineering

References: Excerpts from a paper by Kevin Finney, Landscape Architect, presented at the Eleventh Annual California Salmonid Restoration Federation Conference, Eureka, CA, March 20, 1993.
Soil Bioengineering – An Alternative for Roadside Managers, by Lisa Lewis

Soil bioengineering is the use of live plant materials and flexible engineering techniques to alleviate environmental problems such as destabilized and eroding slopes, streambanks, and trail systems. Unlike other technologies in which plants are chiefly an aesthetic component of the project, in soil bioengineering systems plants are an important structural component.

The system of technologies, which today we call soil bioengineering, can be traced to ancient peoples of Asia and Europe. Chinese historians, for example, recorded use of bioengineering techniques for dike repair as early as 28 BC. Early western visitors to China told of riverbanks and dikes stabilized with large baskets woven of willow, hemp, or bamboo, and filled with rocks. In Europe, Celtic and Illyrian villagers developed techniques of weaving willow branches together to create fences and walls. Later, Romans used fascines, bundles of willow poles, for hydroconstruction.

By the 16th Century, soil bioengineering techniques were being used and codified throughout Europe from the Alps to the Baltic Sea and west to the British Isles. One of the earliest surviving written accounts of the use of soil bioengineering techniques, a publication by Woltmann from 1791, illustrated use of live stakes for vegetating and stabilizing streambanks (Stiles, 1991, p.ii). About the same time, other early soil bioengineers working in Austria were developing live siltation construction techniques, planting rows of brushy cuttings in waterways for trapping sediment and reshaping channels.

Much of the development and documentation of soil bioengineering techniques, since the Industrial Revolution, has been done in the mountainous areas of Austria and southern Germany. Extensive logging of the forests in the region resulted in increased environmental problems, much like what we see in the United States today. Such problems as extreme slope erosion, frequent landslides and avalanches, and severe streambank degradation, required repair. By the turn of the century, European soil bioengineers had begun to find new applications for old folk technologies, using them to develop methods to deal with the new environmental problems. These early soil bioengineers, mostly foresters and engineers by training, began to study traditional techniques and to publish their work. This compiled body of knowledge is where the soil bioengineering profession would develop in the following decades.

The biggest boost to development of new soil bioengineering techniques in Europe came as a result of political developments during the 1930s. Financial restrictions of pre-war years in Germany and Austria favored use of low cost, local materials and traditional construction methods for public works projects. Construction of the German Autobahn system during this time involved extensive applications of soil bioengineering technologies. Use of indigenous materials and traditional methods was also consistent with spreading nationalist ideology. In 1936, Hitler established a research institute in Munich charged with developing soil bioengineering techniques for road construction (Stiles, 1988, p.59). Although this development work was lost, a Livonian forester named Arthur von Kruedener, the head of the institute, continued to work in the field and is known in central Europe as the father of soil bioengineering.

At the same time the Germans were establishing their research institute, some of the most important early soil bioengineering work in the United States was being done in California. Charles Kraebel, working for the USDA Forest Service, was developing his "contour wattling" techniques for stabilizing road cuts. Kraebel used a combination of bioengineering techniques, including live stakes, live fascines, and vegetative transplants, to stabilize degrading slopes in the National Forests of central and southern California. His use of the term "wattle" to describe his live fascine systems has stuck with us and continues to be used today. Kraebel's work was well documented in USDA Circular #380, published in 1936. Two years later, the Soil Conservation Service, now known as the Natural Resource Conservation Service (NRCS), began a study of bluff stabilization techniques along the shores of Lake Michigan. That agency's work, which included use of live fascines, brush dams, and live stakes, was published in 1938 (Gray and Leiser, 1982, p.188).

During the post-war period, European soil bioengineers returned to studying, developing and evaluating new techniques. In 1950, a committee of soil bioengineers from Germany, Austria, and Switzerland was formed to standardize emerging technologies that became part of the German National System of Construction Specifications, the DIN (Robbin B. Sotir & Associates, Inc. n.d.).

Arthur von Kruedener's book, *Ingenieurbiologie*, (Engineering biology), was published in 1951 and it was the mistranslation of the German title which gave us the English term we use today. The use of the term bioengineering has caused some confusion and has proven problematic for researchers who find, in this country, the term most often refers to an area of medical research. NRCS now refers to this work officially as "soil bioengineering," a term that emphasizes the soil component of the system.

German and Austrian soil bioengineers continued to perfect their techniques and to publish their work through the 1950s and 60s. This was an important step in launching a more structural approach, laying the foundation for development of the professional field of soil bioengineering. In the United States, two important projects were carried out in the 1970s and 80s. These include Trials of Soil Bioengineering Techniques in the Lake Tahoe Basin designed by Leiser and others (1974), and Revegetation Work in Redwood National Park (Reed and Hektner, 1981, Weaver, et al., 1987). Both of these studies have been well documented and provide important information about application of soil bioengineering techniques in the western United States.

In 1980, Hugo Schiechtl's *Bioengineering for Land Reclamation and Conservation* was published in Canada. It presents, for the first time in English, the work of many important European soil bioengineers including Lorenz, Hassenteufel, Hoffman, Courtorier, and Schiechtl himself. The book made technologies, and history of their development and applications, accessible to the English-speaking world. In 1997, another Schiechtl book was published, *Ground Bioengineering Techniques for Slope Protection and Erosion Control*. To date, his writings remain the most important work on soil bioengineering in the English language.

Subsequent publications, including Gray and Leiser's *Biotechnical Slope Protection and Erosion Control* and Sotir and Gray's *Soil Bioengineering for Upland Slope Protection and Erosion Reduction in the United States*, Gray and Sotir's *1996 Biotechnical and Soil Bioengineering Slope Stabilization*, and the British Construction Industry Research and Information Association's *Use of Vegetation in Civil Engineering* have made bioengineering technologies better known in the engineering profession. However, there is still resistance to the techniques in many countries.

Soil bioengineering approaches most often use locally available materials and a minimum of heavy equipment, and can offer local people an inexpensive way to resolve local environmental problems. The public's increased environmental consciousness often makes soil bioengineering solutions more acceptable than traditional "hard" engineering approaches.

Despite, and maybe because of, the differences in approach and philosophy between soil bioengineering and other engineering methods of addressing environmental problems, soil bioengineering technologies are especially appropriate today. The scale and range of environmental problems require consideration of new technologies even when, as illustrated earlier, they are in fact centuries old.